

THE MINERAL INDUSTRY OF

FINLAND

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On January 1, 1995, Finland acceded to the European Union (EU). At that time, amendments to the Finnish Mining Law concerning reciprocity took effect and allowed any individual, corporation, or foundation having its principal place of business or central administration within the EU to enjoy the same rights to explore for and exploit mineral deposits as any Finnish citizen or corporation. This has encouraged foreign investment and increased exploration activities of major and junior companies. Exploration emphasis was on base-metal, diamond, and gold deposits.

Mineral legislation and regulations are covered under the Mining Act (Kaivoslaki 503/65), the Mining Decree (Kaivosasetus 663/65), and Amendments to the Mining Law (1427/92, 1625/92, 474/94, 1571/94, 208/95, 561/95, and 1076/95). These are referred to collectively as the "Mining Law". The minerals covered by the Mining Law include about 50 metals and 30 minerals, as well as gems, marble, and soapstone (Kortman and others, 1996).

Government involvement in the mineral industry was considerably higher than in any of the other EU countries. Government-owned companies, such as Finnminers Group (hard-rock drilling/materials handling and ore processing), Kemira Oy (chemicals), Outokumpu Oyj (base metals mining and mining technology), and Rautauukki Oy (steel production), dominated the domestic mineral industry, and Government organizations, such as the State Geologic Research Institute and the State Technological Research Center were active in exploration and research. Because of Outokumpu and Finnminers, Finland was a world leader in the technology of underground mining, ore processing, and metallurgy.

The country has well-established mining, mineral-processing, and refining industries; the diminishing supply of indigenous metalliferous raw materials, however, required that most of the feed for smelters (100% of iron ore concentrate, 80% of zinc concentrate, and 60% of nickel matte and concentrate) be imported from various sources. Production of ores and minerals showed a small overall increase compared with that of 1996. (*See table 1.*)

The major mineral resources companies are listed in table 2. Outokumpu's Kemi Mine, the only chromite mine in Finland, was a significant chromite producer. Current output was around 1 million metric tons per year of chromite ore from two open pits. The ore was processed by a multistage concentration method, that is based on the specific gravity between the minerals, as well as on their magnetic properties. The output of about 600,000 metric tons per year (t/yr) of concentrates (upgraded lumpy ore and metallurgical-grade concentrate) was used as raw materials at Outokumpu's Ferrochrome Works at Tornio (Outokumpu Oyj,

1997, Outokumpu Chrome Oy, accessed July 9, 1998, at URL <http://www.outokumpu.fi/basemetals/copper.htm>).

Although it has no primary copper mines, Finland does produce copper as an associated mineral from Outokumpu's primary zinc mine at Pyhäsalmi. Outokumpu's blister copper capacity was 160,000 t/yr, cathode copper capacity was 125,000 t/yr, and nickel capacity was 32,000 t/yr. Overall, Outokumpu produces 2% of the world copper (Outokumpu Oyj, 1997, Products—Copper, accessed June 29, 1998, at URL <http://www.outokumpu.fi/basemetals/copper.htm>).

Finland has never been a major gold producer, although exploration for gold in 1997 was being conducted by several domestic and foreign companies, as well as the Geological Survey of Finland (GSF). Activity was mainly centered on the Lapland Greenstone Belt and the Archean Greenstone Belt of eastern Finland and the Svecofennian Schist Belt in the south.

Terra Mining Oy started open pit gold operations at the Pahtavaara Mine in June 1996 and achieved full production in 1997. Gold mineralization occurs within a distinct talc/chlorite alteration zone, which is up to 100 meters (m) wide and appears to be a typical splay structure related to a major east-west shear zone. Within this alteration zone, gold is present in quartz-barite vein zones up to 10 m wide. Geologically, the style of mineralization is very similar to shear-zone-hosted gold deposits related to major breaks in the Canadian Shield of North America. Terra completed 2400 m of drilling in nine holes designed to further test the down plunge extension of the steeply dipping ore zones being mined. All nine holes intersected the mineralization at depths between 100 and 250 m below surface (Williams Resources Inc., 1997, Untitled, accessed February 20, 1998, at URL <http://www.info-mine.com/william.htm>).

The only remaining domestic nickel mine in operation in 1997 was Outokumpu's Hitura Mine, which has produced more than 8 million metric tons of ore since 1965.

All steel production in Finland was from imported concentrates and iron pellets. Two-thirds of the raw material came in the form of fines from Sweden's Luossavaara-Kiirunavaara AB. The balance came from Russia in the form of iron pellets from Kostamus and fines from Olenogorsk.

The Finnish government sold 26.5% of its 68.7% stake in the country's largest steelmaker, Rautaruukki Oy. SBC Warburg and Union Bank of Switzerland exercised their option to purchase 3.8 million shares in the company. This brings the total number of shares sold to institutional investors to 31.9 million and 7.4 million, respectively; the selling price was \$8.30 per share. The capital raised will be used to complete the company's current investment program, including the upgrading of flat products operations. The Government was expected to keep its remaining

holding of 42.3% in Rautaruukki for the foreseeable future (Metal Bulletin, 1997).

The only mine producing zinc in 1997 was Outokumpu's Pyhäsalami Mine at Pyhajarvi. The zinc concentrate was shipped to the Kokkola smelter, and the associated copper concentrate was shipped to the Harjavalta smelter. Pyhäsalami, together with Outokumpu's Tara Mine in Ireland, supplied about 80% of the feed for the Kokkola smelter.

Outokumpu announced that it would make a total investment of about \$90 million in the zinc plant in Kokkola, whereby the production capacity would be increased by about one-third from 170,000 to 225,000 t/yr of zinc. Implementation was expected to take about 2 years. Use of a new direct method of leaching zinc concentrates, developed by Outokumpu, was expected to improve productivity significantly (Outokumpu Oyj, 1997, Untitled, accessed October 29, 1997 at URL <http://www.outokumpu.fi/NEWINFO/press/kokkola.htm>).

Outokumpu signed an agreement for nickel matte with Mineração Serra Fortaleza, Minas Gerais, Brazil, a wholly owned subsidiary of the Rio Tinto Group. Outokumpu will buy the planned 10,000 t/yr of nickel matt from the new Fortaleza smelter for a period of 10 years and supplied a license to use its direct nickel smelting process and provided expertise for the Fortaleza smelter. The metal will be shipped to the Harjavalta refinery in Finland. Harjavalta has a potential capacity of 40,000 t/yr, and the agreement with Fortaleza would help ensure the continuity of long-term supplies (Mining Journal, 1997b).

Malmikaivos Oy discovered a series of kimberlite bodies in northern Finland. Malmikaivos, a fully owned subsidiary of Ashton Mining of Australia, discovered 30 kimberlite pipes, one-half of which were diamondiferous. Two pipes, which were closely studied, contained quantities of clear and colorless diamonds. A surface sample of 23 metric tons was taken from a pipe with a 2 hectare (ha) area, which yielded 26 carats per 100 t, mostly of good quality. Another pipe, slightly more than 1 ha, contained 13 to 26 carats per 100 t based on a 9.4-t sample (Geological Survey of Finland, 1997, Diamond exploration, accessed May 29, 1997 at URL <http://www.gsf.fi/explor/minfinl.htm>).

To was expanding its exploration for kimberlite pipes Ashton Mining entered into an agreement with Dia Met Minerals Ltd. of Canada. A country-wide regional sampling program has identified several prospective areas. The joint venture covered two areas in the eastern part of the country; one of 38,475 square kilometers (km²) and another of 40,750 km² (Northern Miner, 1998). Several other companies, including Rio Tinto Mining & Exploration Ltd., Finnsearch Oy, Conroy Plc. of Ireland, and Baltic Minerals Finland Oy, were active in diamond exploration; none of the companies had issued any preliminary findings at yearend.

Finnminerals Oy was the largest producer of paper-grade talc in Europe and Finland's sole producer of talc. Previously part of the largest European paper conglomerate, UPM-Kymmene, Finnminerals was sold to Western Mining Corp. Holdings Ltd. of Australia (50%) and Plüss-Stauber AG of Switzerland (50%). The company also had talc slurry plants in the Netherlands and Sweden.

Talc de Luzenac, a French subsidiary of Rio Tinto of the United

Kingdom, won the bid to investigate a talc deposit at Sotkamo in northern Finland. It has 2 years to in which to evaluate the size, quality, and economics of the deposit prior to making a development decision. The worlds largest producer of talc, Talc had 15 operations in Europe and North America (Mining Journal, 1997a).

GSF placed emphasis on exploration for pigment minerals, such as ilmenite, high-quality carbonates, and kaolin. Also, a number of dimension stone deposits were being assessed by various companies.

Finland was one of the largest energy consumers in western Europe. Only about one-third of its energy requirements were satisfied by indigenous sources, namely, hydro and nuclear power, peat, and wood. All other energy sources, such as coal, natural gas, and petroleum, were imported.

Finland was seeking to bring its two principal public energy companies—the oil and chemical group Neste and the electricity company Imatran Voima (IVO), into a closer partnership, with a possible merger of the groups. IVO began to prepare for the liberalization of the European energy market by taking over the Swedish company Gullspang Kraft in 1996 (Energy News, 1997, Finland could merge oil and Electricity, accessed June 19, 1997, at URL <http://www.info.ft.com/media/June 1997.htm>).

The operating environment in Finland is generally favorable for exploration and mine development. GSF identified a number of mineral deposits for which information was available. The country has a long mining history and a traditional focus on primary resources, such as mining, forestry, and farming. Finnish mining equipment manufacturers were recognized throughout the world's mining community.

Finland can be considered to be an attractive exploration target in several respects. Geoscientific data coverage is excellent, infrastructure is highly developed with good port facilities, an extensive high-voltage power grid, and a comprehensive road network. Taxation laws are favorable, and the mining law is strong. Large areas can be considered to be under explored for many commodities, and the likelihood of additional discoveries may be enhanced with the entrance of foreign companies into the Finnish mineral industry. Lastly, the country is located in close proximity to major markets.

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Major Source of Information

Geological Survey of Finland
Betonimiehenkuja 4
02150 Espoo
Finland

TABLE 1
FINLAND: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997 e/
METALS					
Aluminum metal, secondary	29,900	35,466	35,090	35,308 r/	33,000
Cadmium metal, refined	785	548	539	648	540
Chromite:					
Gross weight:					
Lump ore e/ thousand tons	191	225	214	210	215
Concentrate e/ do.	300	341	373	360	365
Foundry sand e/ do.	20	7	11	12	9
Total do.	511	573	598	582	589
Cr2O3 content:					
Lump ore e/ do.	45	76	80	70	75
Concentrate do.	170	150	150	150	150
Foundry sand e/ do.	3	3	3	3	3
Total do.	218	229	233	223	228
Cobalt, metal, powder, and salts	2,150	1,443	1,709	2,110 r/	2,000
Copper:					
Concentrate, gross weight	44,154	34,410	26,000	24,000	22,000
Mine output, Cu content	11,131	13,243	9,790	9,261 r/	8,500
Metal:					
Smelter	107,201	129,265	120,577	178,675 r/	159,000
Refined	73,373	69,177	73,700	110,715 r/	116,000
Gold metal kilograms	1,385	1,372	2,061	3,070 r/	3,100
Iron and steel, metal:					
Pig iron thousand tons	2,535	2,597	2,242	2,457	2,780 2/
Ferroalloys, ferrochromium do.	218	254	247	228 r/	230
Steel, crude do.	3,255	3,419	3,176	3,301	3,687 2/
Semimanufactures, rolled do.	2,300 e/	3,121	3,242	3,272	3,295 2/
Mercury	98	83	90	88	90
Nickel:					
Concentrate, gross weight	127,400	107,865	110,000 e/	100,000 r/ e/	10,000
Mine output, Ni content	8,290	7,652	3,439	2,136 r/	3,000
Metal, electrolytic	14,777	16,902	21,268	29,141 r/	30,000
Platinum-group metals:					
Palladium kilograms	100 e/	96	95	182 r/	180
Platinum do.	--	37	37	62 r/	60
Selenium metal do.	30,400	30,000	29,690	42,000 r/	40,000
Silver metal do.	15,896	26,100 r/	26,098	32,506 r/	32,500
Zinc:					
Concentrate, gross weight	42,400	41,971	43,000	58,000	60,000
Mine output, Zn content	22,529	16,916	16,385	26,294 r/	30,800
Metal	170,934	173,200	176,600	176,300	175,300
INDUSTRIAL MINERALS					
Cement, hydraulic thousand tons	835	864	907	975 r/	960
Feldspar	51,477	43,483	41,808	40,265 r/	40,000
Lime thousand tons	250 e/	321	401	394 r/	400
Mica	4,488	5,591	--	--	--
Nitrogen, N content of ammonia	10,000 e/	11,894	5,933	5,107 r/	6,000
Phosphate rock, apatite concentrate:					
Gross weight thousand tons	628	657	671	657 r/	650
P2O5 content do.	227	236	243	240 r/	235
Pyrite, gross weight do.	691	839	829	813 r/	950
Sodium sulfate do.	30 e/	36	34	29 r/	30
Stone, crushed:					
Limestone and dolomite:					
For cement manufacture thousand tons	1,005	1,047	1,114	1,128 r/	1,200
For agriculture do.	1,035	898	787	892 r/	900
For lime manufacture do.	348	343	335	303 r/	300
Fine powders do.	568	382	316	289 r/	300
Metallurgical e/ do.	2	2	2	2	2
Total do.	2,958	2,672	2,554	2,614 r/	2,702
Quartz silica sand do.	167	71	30	31 r/	30
Soapstone do.	27	29	31	--	--

See footnotes at end of table.

TABLE 1-Continued
FINLAND: PRODUCTION OF MINERAL COMMODITIES1/

(Metric tons unless otherwise specified)

Commodity	1993	1994	1995	1996	1997 e/	
INDUSTRIAL MINERALS--Continued						
Sulfur:						
S content of pyrite	thousand tons	292	369	422	425	430
Byproduct:	do.					
Of metallurgy	do.	225 e/	216 r/	215	291 r/	290
Of petroleum	do.	32 e/	41	37	38	40
Total	do.	549	626 r/	674	754 r/	760
Sulfuric acid	do.	1,300 e/	1,084	1,159	1,287 r/	1,200
Talc	do.	399	453 r/	464	345 r/	350
Wollastonite		26,796	27,757	29,592	22,304	20,000
MINERAL FUELS AND RELATED MATERIALS						
Peat:						
For fuel use	thousand tons	3,945	6,960 r/	6,300 r/	7,200 r/	8,000
For agriculture and other uses	do.	500 r/	1,040 r/	750 r/	1,850 r/	2,000
Petroleum refinery products	thousand 42-gallon barrels	76,000 e/	80,486	79,000 r/	83,000 r/	82,000

e/ Estimated. r/ Revised.

1/ Table includes data available through May 1998.

2/ Reported figure.

TABLE 2
FINLAND: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
Ammonia		Kemira Oy (Government, 98%)	Plant at Oulu	75
Cadmium, metal		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Kokkola	1
Cement		Partek Cement Oy (Partek Corp., 50%; Metra Corp., 50%)	Plants at Lappeenranta and Pargas	1,200
Chromite		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Kemi	730
Copper:				
Ore, Cu content		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mines at Pyhäsalmi, Saattopora, and Hitura	10
Metal		do.	Smelters at Harjavalta and Pori	160
Feldspar		Lohja Oy (Metra Corp., 100%)	Mines and plants at Haapaluoma, Kemio, and Peraseinajok	50
Ferrochrome		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Tornio	230
Gold:				
Ore, Au content	tons	do.	Mine at Orivesi	4
Metal	do.	do.	Smelter at Pori	4
Ore, Au content	do.	Terra Mining Oy (Williams Resources Inc., 100%)	Pahtavaara Mine near Sodankyla	3
Limestone		Partek Minerals Oy (Partek Corp., 100%)	Mines at Kolari, Lappeenranta, and Pargas	1,900
Do.		Lohja Oy (Euroc, 100%)	Mines at Mustio and Sipoo	1,650
Do.		Rauma-Repola Oy	Mine at Turnio	300
Mercury	tons	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Kokkola	150
Mica		Kemira Oy (Government 98%)	Mine at Siilinjärvi	10
Nickel:				
Ore, Ni content		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Hitura	3
Metal		do.	Smelter at Harjavalta	32
Phosphate-apatite		Kemira Oy (Government, 98%)	Mine at Siilinjärvi	700
		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mine at Pyhäsalmi	800
Quartz and quartzite		Lohja Oy (Euroc, 100%)	Mines at Kemio and Nilsia	250
Selenium	tons	Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Smelter at Pori	35
Silver	do.	do.	do.	30
Steel		Rautaruukki Oy (Government, 42.3%)	Plant at Raahe	2,100
Do.		Fundia AB (Norsk Jenverk AS of Norway, 50%; Rautaruukki, 50%)	Plants at Aminnefors, Dalsbruk, and Koverhar	850
Do.		Ovako Oy (SKF, 50%; Wartsila, 25%; Fiskas, 20%)	Plant at Imatra	600
Talc		Finnminerals Oy (Western Mining Corp. Holdings Ltd., 50%; Plüss-Stauffer AG, 50%)	Mines at Lahnaslampi, Lipsavaara, Luikanlahti, and Poljivari	500
Wollastonite		Partek Minerals Oy (Partek Corp., 100%)	Mine at Lappeenranta	30
Zinc:				
Ore, Zn content		Outokumpu Oyj (Government, 40%; Insurance Co., 12.3%)	Mines at Pyhäsalmi and Mullikkoräme	25
Metal		do.	Smelter at Kokkola	175